two individuals (or parts of them) are so united as to have a common vascular system; and the connection which this result seems to suggest, of a direct relation between chemical change in the blood and histological differentiation in the tissues, opens up a promising field for further work.

The hind end of a larva, grafted in the manner described on to the body of a second larva, can be reared up to the time of metamorphosis. It seems to grow normally, up to the point of section, except that its rectum, if present, communicates with that of the stock. There is apparently little or no nervous connection between stock and graft, since gentle stimulation of the graft causes reflex movement only of that tail, the stock remaining quiescent, and *vice versâ*.

In a similar way an excised head, grafted into the ventral surface of a second larva, may remain without nervous connection with the stock. The two are connected chiefly through the œsophagus of the graft, which fuses with and opens into the alimentary canal of the stock, and by the blood vessels. Such a grafted head shows snapping and respiratory movements, which are independent of those performed by the head of the stock, and have a different rhythm. As before, the grafted head may be larger or smaller than the head of the stock, but the rate of histological differentiation is the same in both.

These experiments go to show that provided a proper food supply be furnished, any portion of a frog larva, after the closure of the medullary folds, will develop in very nearly the same way, whether it be in its normal relation to the rest of the embryo or not, up to the period of metamorphosis. Indeed, the death at metamorphosis appears at least in many cases to be simply caused by mechanical injury which the stock inflicts upon the graft, by scraping it against foreign bodies—a phenomenon obviously connected with the absence of nervous communication between the two. It is especially pointed out that the position of the grafted portion has no obvious influence on the result: so that nothing like the "polarity" observed by Wetzel in his experiments with Hydra, and by others in similar cases, can be seen in the larval frog.

The cases so far mentioned involve the union of comparatively small portions of one larva with the nearly complete body of a second. More complicated unions are effected by slicing a small piece from the ventral or from the dorsal surface of each of two larvæ, and joining the two by their wounded surfaces, so that two nearly complete larvæ are united. The relation between such components follows the same rule as that found to hold for the unions already described: the rate of growth may differ to a considerable extent, but the rate of histological differentiation is always the same. In these cases, and in those presently to be mentioned, corresponding organs, which are in contact at the point of section, unite; and hollow organs, such as gut, nervous system, heart, cœlom, unite in such a way that the cavity of one component communicates with the homologous cavity of the other. In ventral unions, therefore, the two components have a common alimentary cavity, a common cœlom, and often a common heart; in dorsal unions they have a common neural cavity, and so on. When corresponding organs unite, there is generally complete histological continuity of the characteristic tissue of the organ from one component to the other, without any formation of scar tissue, so that nerve fibres run across the line of junction of two brains; gastric epithelium evenly across the junction of two stomachs, and so on.

Detailed descriptions of many of these unions are given, but some of the most interesting are as yet withheld. Some of the results of these unions have been successfully reared through the metamorphosis, and are now frogs. The reasons which have prevented Prof. Born from killing these creatures in order to describe their structure will be easily understood.

A third series of specimens is obtained by uniting the front portion of one larva to the hinder portion of another; and where about each component contains about half a larva, the result seems to be almost indistinguishable from a normal individual. A case is described in which the anterior two-thirds of one larva was united with the posterior two-thirds of the other; the resultant creature has been reared through the metamorphosis, and is now a frog with a trunk of abnormal length.

The way in which corresponding organs unite across the plane of section in cases of this kind is truly remarkable, and induces a belief in some adjustment of the parts after apposition. For example, the pronephric ducts unite so that the cavity of the anterior portion of the duct communicates with that of the posterior portion; and in spite of the very wonderful manipulative skill which Prof. Born must have attained, it is difficult to believe that such minute structures can have been even frequently adjusted by him with absolute accuracy at the time of operation; indeed, in the case of the much larger spinal cord there are sometimes obvious indications of a readjustment.

The last series of experiments described demonstrates the possibility of obtaining some of the results by joining larvæ or portions of larvæ belonging to different species, or even to different genera. Unions are figured between *Rana esculenta* and *Bombinator igneus*.

The experiments are not yet concluded, and it would be presumptuous to do more than describe them; at the same time, their interest is so great that it has seemed worth while to do this at considerable length.

W. F. R. WELDON.

EFFECTS OF HIGH ALTITUDE UPON MAN.

La Cure d'Altitude. Par le Dr. Paul Regnard. Pp. viii + 436. 8vo. 29 plates; 110 figures in the text. (Paris: Masson et Cie., 1897.)

THE hardihood and endurance of mountaineers has been always celebrated. A Swiss Protestant clergyman, Kraenbühl, noticed a great difference between children from the mountains and those of certain schools in Zürich and Bern. He arranged for some of the weakly children from the towns to live at Beatenberg in the mountains, and after some months had the satisfaction of seeing these children much improved; in fact, completely changed for the better. This occurred about 1850, and attracted many delicate persons to

Beatenberg. The present reputation of Alpine health resorts is, therefore, of comparatively recent date, especially so their use as places of residence during winter, and any one visiting Davos to-day would hardly believe that it is only about thirty-two years back since the first invalids came there for their health.

The French employ Alpine health resorts much less than the English and Germans, and therefore Dr. Paul Regnard is all the more to be congratulated on the production of his capital book; it is written in the clear lucid style for which French scientific writers have become celebrated, and it gives us a satisfactory explanation of the principles on which the curative and exhilarating influences of residence in high altitudes depend. The author carries us over the scientific ground pleasantly enough, laying before us, in admirable order, the various observations of practitioners, and the experimental investigations which have been undertaken both in the mountains and in laboratories to explain the action of the phenomena observed. The result of all this work is that the use of mountain climates is no longer empirical, but rests on a well-established scientific basis.

One of the most interesting phenomena observed in human beings and animals, when removed to high altitudes, is the change which takes place in the quality of their blood; and on this subject the author is well qualified to speak, for much of the investigation concerning it has been carried out by his compatriots, and he himself has undertaken several original experiments to settle doubtful points.

Paul Bert discovered that the blood of animals living in high altitudes absorbed more oxygen than that of similar animals at ordinary elevations, and in this observation he was soon confirmed by Müntz, who removed rabbits from Tarbes to the Pic du Midi de Bigorre in the Pyrenees (2377 metres), where they remained close to the observatory on the summit of the mountain, and bred naturally. This was in 1883, and in 1890 Müntz compared the blood of rabbits born on the mountains with that of rabbits of the plain, and found that the former was richer in hæmoglobin, and absorbed more oxygen than the latter. Viault found that at high altitudes the red corpuscles of the blood increased rapidly in numbers, and out of proportion to the increase in hæmoglobin. The work was taken up by Egger and Mercier, of Arosa, and Prof. Miescher, of Bâle, and no doubt was left that the red blood corpuscles notably increased soon after residence in places of high altitude. Egger found that the hæmoglobin was likewise notably increased, but not relatively so much as the number of red corpuscles. When residents of the mountains descended to live in the plain, he found that the number of their red corpuscles fell to the normal. Mercier considered that the degree of increase in the number of corpuscles varied directly with the altitude. Sellier tried the effect on animals of an atmosphere abnormally rich in oxygen. His results were doubtful, but the carefully conducted experiments of Regnard himself seem to establish the fact that when animals are kept for a considerable time in an atmosphere containing too much oxygen, their red corpuscles decrease in number.

It is clear that Dr. Regnard assigns a great part of the effect of mountain resorts to the influence of the altitude on the blood. To illustrate his views, we may take the case of a consumptive person. By life in town and under other unhealthy influences, he has become anæmic and badly nourished; consequently his tissues are less able to withstand the tubercle bacillus, and he becomes infected. He then goes, we may suppose, to some Alpine resort, either directly, or after resting some time at an intermediate station. Owing to the diminished amount of oxygen in the air at high elevations his blood is not able to absorb enough for its proper requirements, and consequently a "reaction" gradually takes place. New "microcytes" are quickly formed, and these develop rapidly into full-sized red corpuscles, and gradually acquire the normal amount of hæmoglobin. Thus the blood becomes richer in red corpuscles and in hæmoglobin; it can absorb more oxygen, and the whole body is better nourished (though fat and comparatively useless material may be lost, so that there may in many cases be an actual decrease in body weight, at first at least), and offers greater resistance to the growth of the bacilli. When the patient descends to lower elevations the number of his red corpuscles slowly returns to the normal amount; the good effects on the general nutrition remain, and the blood, though not so rich in corpuscles and hæmoglobin as it was in the mountains, is of good quality and not below standard, as it probably was when the illness commenced.

Mountain sickness results, according to the author, from the diminished pressure of oxygen in the atmosphere, and its consequent diminution in the circulating blood, at a time, moreover, when on account of the muscular exertion of climbing it is especially needed. It is, in fact, due to asphyxia of the tissues. Prof. Clifford Allbutt and most authorities are practically now agreed that deprivation of oxygen is the essential cause of *mal des montagnes*.

The author believes that a comparative immunity from phthisical contagion is obtained at high altitudes in spite of the presence of phthisical patients and of the "contagium vivum," which the more careless of them scatter about with their expectoration. This he attributes partly to the excellent "sanguinification" of those resident in high altitudes, and their consequent resistance to the bacilli of tuberculosis, and partly to some antiseptic action of the climate which is capable of diminishing the number and virulence of these microbes outside the body.

Though he points out the charms of mountain resorts, Dr. Regnard is careful to speak of trials which sometimes await the visitor. It is in spring when the snow is melting, that the Mediterranean resorts triumph, but then succeeds the rapid growth of vegetation in the mountains, one of the most beautiful sights afforded by nature. The fogs which come with rainy weather cause a moist cold which may be very trying, and these are perhaps the chief drawbacks of the Alps. The dust of the roads at some localities are amongst the drawbacks which disappear during winter, when the ground is covered with ice and snow.

In the second part of the work, that chiefly devoted to an account of the individual resorts, Dr. Regnard is responsible for the new term "Hypsiatrie" (*i.e.* treatment by high altitudes). The localities described have been visited by the author, and views of many of them are given. We must note one drawback which the volume has, in common with most French books, namely, the absence of an index.

F. P. W.

ELECTRO-METALLURGY.

Electric Smelting and Refining: the Extraction and Treatment of Metals by means of the Electric Current. Being the second edition of *Elektro-Metallurgie*, by Dr. W. Borchers. Translated, with additions, by Walter G. McMillan. Pp. xx + 416. With numerous illustrations. (London: C. Griffin and Co., Ltd., 1897.)

THOUGH electro-metallurgy may still be regarded as in its infancy, it is such a lusty youngster and is making such rapid progress that it is high time that a good manual on the subject in the English language should be available to our engineers. No better work is wanted than a translation of Dr. Borchers' well-known treatise, and it has been excellently put into English by Mr. McMillan, who has also done his best to bring the work up to date, a task rendered all the easier by reason of the shortness of the time (considerably less than two years) that has elapsed since the publication of the German edition. The additional matter mainly concerns the practical aspect of the subject, accounts of actual applications of processes to which little or no reference is made in the German text being inserted under many of the subheads. With these additions, enough is stated to give a good general idea of the present industrial position of electro-metallurgy.

Little space is devoted to introductory matter, the author plunging into the thick of his subject almost at once. A short account, however, is given of the newer electro-chemical theories, but the student is referred for fuller explanations to the works of Ostwald and Nernst.

In Part i., which deals with the alkali and alkaline earth metals, the most interesting section is that on the carbides of calcium, strontium, and barium. The history of the subject is noticeable, as it differs somewhat from that given by M. Moissan in the *Annales de Chimie et de Physique* last year. Thus Dr. Borchers claims to have produced the carbide of calcium in his electric furnace as long ago as the year 1880, although no use was made of the discovery, which was not published until 1891, until "the later researches of Maquenne, Travers, and Moissan first recalled attention to this class of compounds" in 1892–94. It is remarkable that Moissan, writing at a later date than Borchers, does not refer to the experiments of the latter. The electric furnace used by Borchers differs from that employed by other experimenters in having a thin carbon pencil connecting two thick carbon cylinders. When the current is passed, the carbon pencil becomes intensely heated owing to the great resistance offered by it, and the charge, which is packed round it, is heated by contact. There is here no possibility of electrolytic action, and it is on the results obtained by the use of this furnace that the author, in 1891, based the law, which he claims to have established, that "all oxides are capable of being reduced by carbon if the temperature is sufficiently high"—a law which has not as yet obtained full recognition.

The most important parts of the book are, however, those dealing with aluminium and copper. In both these sections the historical accounts are particularly good, the progress of events in the electrolysis of fused compounds of aluminium, for example, being traced from the experiments of Davy in 1807 to the practical installation of the Hall process at Pittsburg, working details of which were not published until 1896. Many patent specifications are given and processes mentioned, some of them being admittedly impracticable, and even, in the author's opinion, absurd, for "we may learn something even from negative results." The good points in each and the causes of failure are carefully pointed out, with the result that the history is made most instructive. It is true that Dr. Borchers shows a pardonable tendency to praise what is German and to criticise and decry the work in the United States and elsewhere; but the translator has in part corrected the impression conveyed by this patriotic prejudice by the additions made in many parts of the book. It is disappointing that details are not forthcoming of the work of the British Aluminium Company, which we learn is now the largest producer of that metal in the world, using 2500 h.-p. at their Falls of Foyers works in Scotland; but it is, of course, not surprising that manufacturers, after spending thousands of pounds and much time over their experiments, should prefer to keep the results to themselves for a time.

The electrolytic refining of fairly pure metallic copper, like the direct reduction of aluminium from its oxide, is of special interest, because all the main difficulties have now been overcome, and a complete account can be furnished. Here again there is a slight tendency on the part of the author to regard the latest German process, the Siemens-Borchers system, as perfection, and to ignore the later American practice, in which a much higher current density is used, and the cost thus materially reduced, in spite of the fact that wages are higher than in Germany. Several exact descriptions of processes in works are given, however, illustrated by capital diagrams, and the whole section is of great value.

Passing to other metals, silver, gold, lead, tin, zinc, and antimony all receive adequate treatment, and an interesting description is given of the various processes of electric welding, local softening, and soldering of iron and steel.

Among minor errors that were noticed may be mentioned the statement on p. 239, that ores of silver and gold are never smelted with copper ores with the design of concentrating the precious metal in the copper. This method, however, has been in use for some time in New Mexico. Again, the melting-point of gold is given as 1035°, a figure long since abandoned, and some erroneous figures are given concerning the relative cost of the Siemens-Halske and other cyanide processes for the treatment of gold ores. Such trivial mistakes do not impair the value of the work, which must of necessity be acquired by every one interested in the subject who does not already possess the second German edition.

There is much material for reflection for engineers in England in the phenomenal rapidity with which the practical applications of electro-metallurgy are advancing in Germany and in America. The consideration, in particular, repeated in this volume over and over again, to